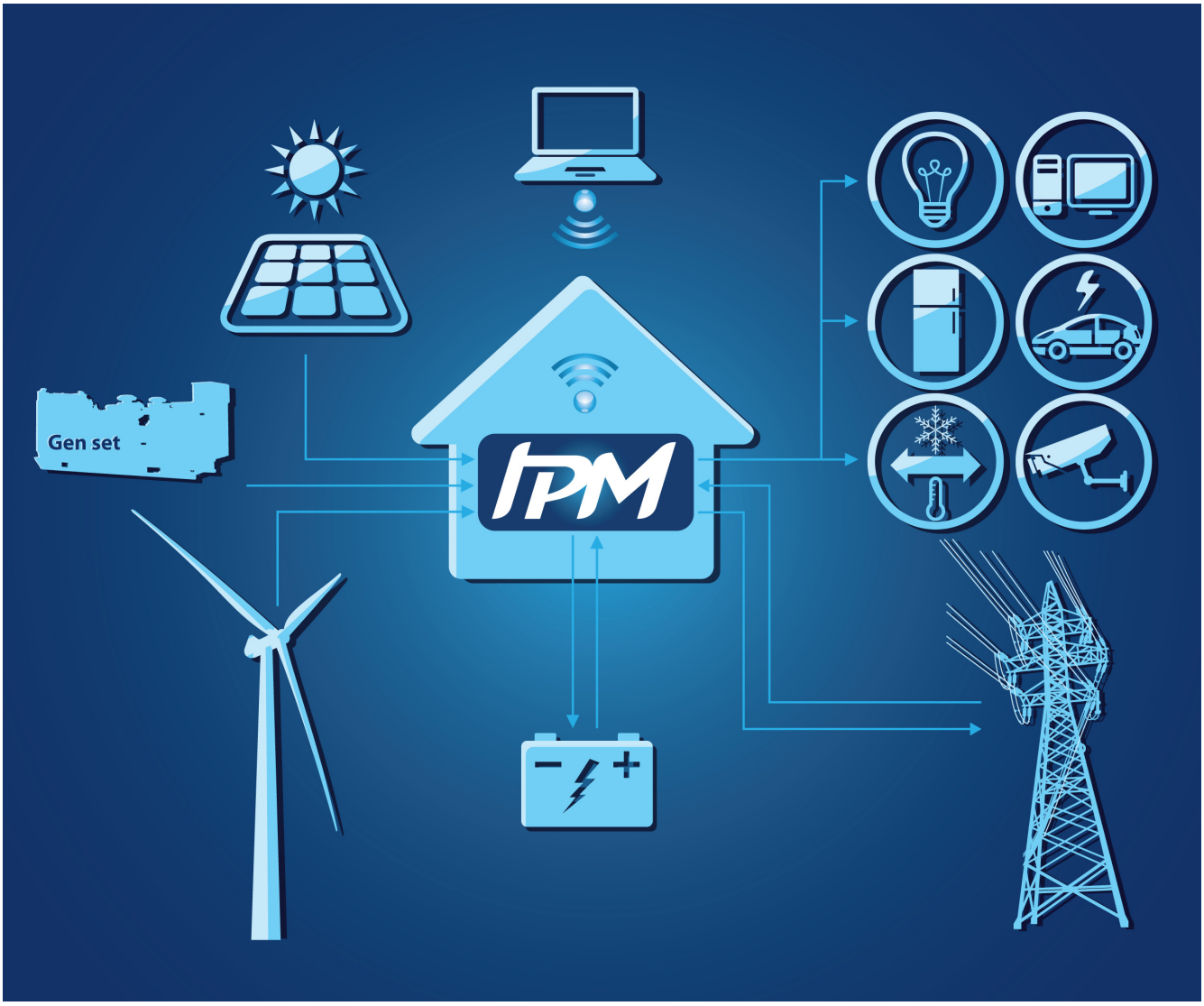
Intelligent Power Manager

User's Manual

Take the power in your hands

CLEAN ENERGY SOLUTIONS
by ELFON


Gen set
IPM

USER'S MANUAL

INSTALLATION GUIDE

PV INVERTER

IPM3
IPM5

IPM001_V.050

SAFETY NOTICE

Photovoltaic components may produce voltages harmful to human health. Always use caution when handling such equipment.

The product you are handling is an electronic device segments of which may possess electric energy harmful to human health. Use the appropriate caution and protection.

Employ only an educated and trained electrician for installation.

The IPM has been designed and tested according to international regulations and standards. Read this manual and follow carefully all instructions in order to avoid injury. Observe all warnings and caution notices.

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1. INTRODUCTION

The IPM is a DC to AC inverter for photovoltaic panels, capable of connecting in parallel to the public grid. Besides simply feeding power into the grid, the IPM allows the user to also manage it. Through programming, the IPM is capable of directing energy to batteries, supporting local loads, and retrieving the stored energy from the batteries.

The IPM is offered in two power ratings: 2.5 kVA and 5.0 kVA. Its intended use is for single phase, home and industrial applications. It features full galvanic AC-DC isolation and is capable of supporting loads with high start-up current requirements.

In general, the IPM operates in any of four modes:

1. Auxiliary Power Unit (APU)
2. Parallel Connection to the grid (Feed in)
3. Stand alone operation (Island)
4. Battery charging

In APU mode, the IPM is connected to the grid and can feed in to or consume energy from the grid at times specified by the user. It can also store and retrieve energy to/from the batteries. This capability allows the IPM to function as an Auxialry Power Unit (APU) that will support the local load by means of the photovoltaic and the battery when the grid fails.

In Feed-in mode, all power produced by the photovoltaic panels is fed into the grid. The user can specify time intervals within the day that this is allowed.

In stand alone mode, the IPM manages the power of the building without being connected to the grid. It stores energy in batteries and retrieves it, and also supports local loads by utilizing the photovoltaic and the battery.

The IPM has been designed for minimum power loss due to voltage conversions, and is particularly suitable for applications that require increased energy storage capacity and support loads with high start-up currents.

The sections that follow describe the safety features, installation and operation of the IPM.

2. SAFETY FEATURES

The IPM has been designed and built according to international regulations and practices. It complies with all applicable standards relating to Electromagnetic compatibility and safety. The inverter also conforms to the local directives that govern the operation of energy generating systems parallel to the low voltage grid.

The IPM uses transformers for galvanically isolating DC and AC currents, thus providing maximum protection.

The IPM includes built-in anti-islanding protection programmable for country-specific regulations.

The IPM continuously monitors grid voltage and frequency. When the detected values deviate from locally accepted tolerances, the inverter automatically stops.

The IPM uses batteries of high voltage. This requires a safe enclosure for the batteries, and suitable connection wires to support the load. For the supported power, due to the high potential of the batteries, the electrical current is relatively low, thus allowing for thinner and flexible wires. This way, a high endurance at low electric current is achieved.

All components (PV panels, inverters, grid) required to compose a system may carry high voltages, dangerous to human health. Make sure all connections and equipment start-up are performed only by qualified personnel.

3. PACKAGING AND TRANSPORTATION

The IPM is packaged in a cardboard crate, which contains the inverter and the wall bracket.

Utilize two persons to lift up the device. Place it on the floor, standing up.

Now it is ready to position on the wall bracket, once the wall bracket is installed.

CRATE CONTENTS -

1pc. Inverter unit
1set Concrete/brick fasteners
1pc. Wall bracket
1pc. User's manual

4. BECOMING FAMILIAR WITH THE IPM

Figures 4.1, 4.2, and 4.3 illustrate the different parts of the IPM. Becoming familiar with the terminology and the device's features will be helpful in installing and operating the IPM with safety.

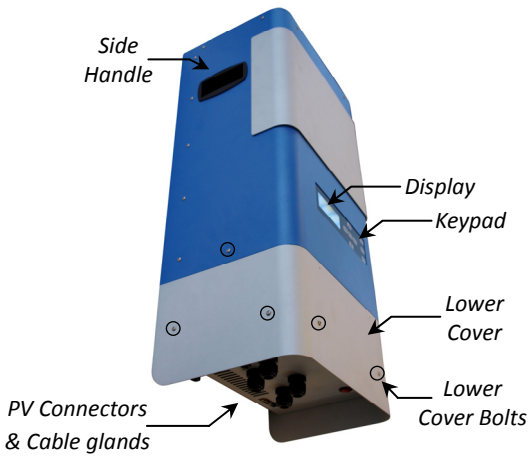


Fig. 4.1 IPM Front View

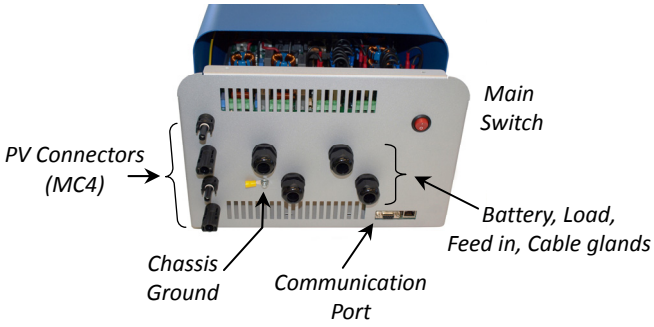


Fig. 4.2 IPM Bottom View

Fig. 4.3 IPM Rear View

5. OVERALL SYSTEM CHARACTERISTICS

The IPM is the central device of a system that produces and consumes electrical energy. It has been designed to provide maximum safety to the user. Care must be exercised when selecting its peripheral devices so that its capacity not exceeded. For system design, follow the guidelines below:

	IPM 3		IPM 5	
COMPONENT	MIN	MAX	MIN	MAX
PV POWER (W_P)	900	3000	900	5000
INPUT VOLTAGE (VDC)	200	450	200	450
BATTERY VOLTAGE (VDC)	220	300	220	300
LOCAL LOAD (W)	0	2400	0	4800

Grid: 230 VAC, 50Hz

Interconnections-

Battery: Use 2,5 mm^2 wire.

Grid, Local load: Use 3 X 2,5 mm^2 wire, 25A breaker.

6. INSTALLATION

The IPM is intended for indoor installation. It must be mounted on a wall and there must be sufficient flow of air to allow for its cooling. When connecting to PV panels, make sure V_{oc} < 450 per string.

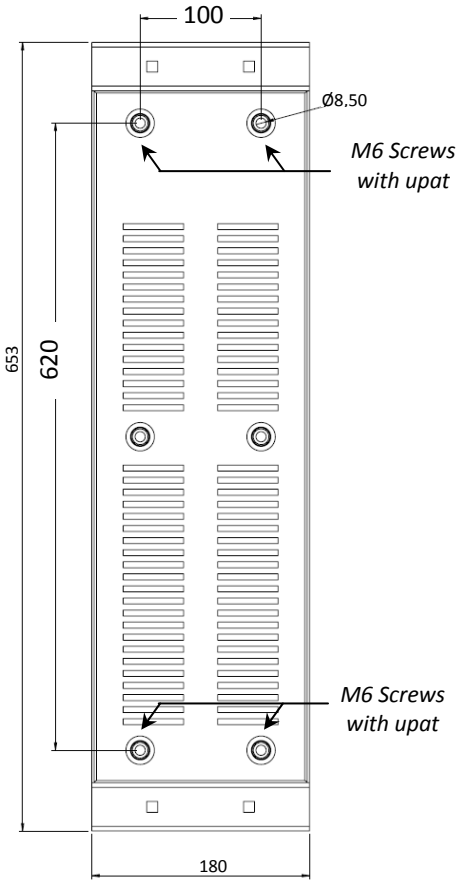


Fig. 6.1 Wall Bracket

Cooling takes place by natural convection and also forced airflow, when necessary. Proper grounding must be provided.

Wall Mounting

The IPM weighs approximately 45 kgs. Therefore, care must be exercised when lifting and when mounting the device on a wall. The wall must be sturdy enough to support the weight.

A wall bracket (Figure 6.1) is fixed onto the wall first and the IPM is positioned and bolted on the wall bracket. Drill four holes for M6 Lag screws with upat at the positions indicated on Figure 6.1.

To make sure the device is installed properly, place the bracket on the wall at its intended position with a level indicator on top of it. Mark the positions of the four screws and drill the holes. Secure the wall bracket on the wall by tightening the screws.

Fig. 6.2. Opening the lower cover

Employ two persons for lifting the IPM. Place one hand in the side handle, tilt it backwards, and place the other hand under the lower cover. Lift carefully and keep slanted, with the top towards the wall. Lower the IPM so that the top of the wall bracket enters the mounting slot (Figure 4.2). Let the lower part of the IPM rest gently on the wall.

Remove the 8 screws (Figure 4.1.) that hold the lower cover in place and detach the cover, as shown in Figure 6.2.

When removing the lower cover, make sure to detach the ground wire that is located in the inside, and to attach it again when replacing the cover. Tighten the two bolts located on the back of the IPM, below the terminal blocks. The device is now secure and ready for the electrical connections.

6.1. SYSTEM CONFIGURATION

Several hardware connection combinations are possible with the IPM. The figures below show schematically possible system configurations.

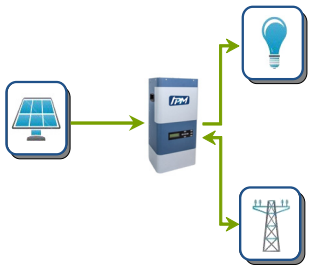


Fig. 6.3. Grid Connected (APU, Feed in)

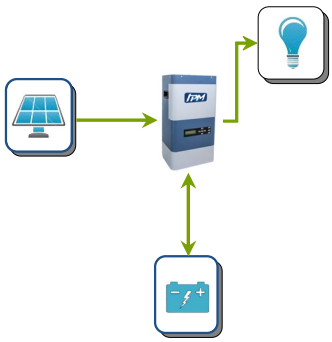


Fig. 6.4. Island

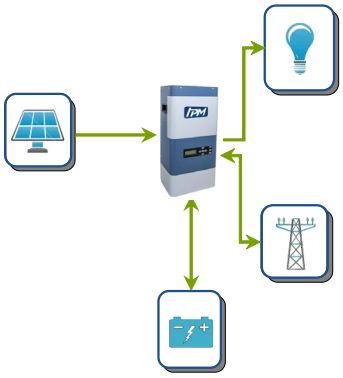


Fig. 6.5. Hybrid (APU)

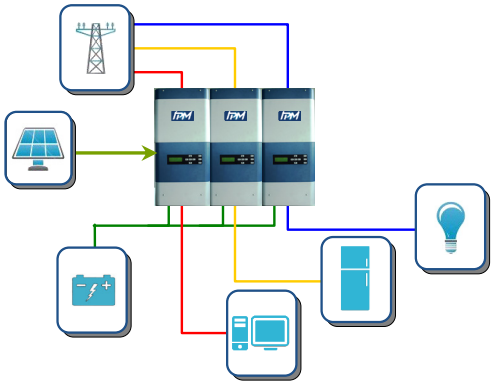


Fig. 6.6. Combined IPMs

7. ELECTRICAL CONNECTIONS

This section describes the sequence and procedure of connecting the various peripheral devices and networks to the IPM. The following instructions and caution notices must be followed carefully for a safe and trouble-free commissioning. A possible system configuration is shown in Figure 7.1.

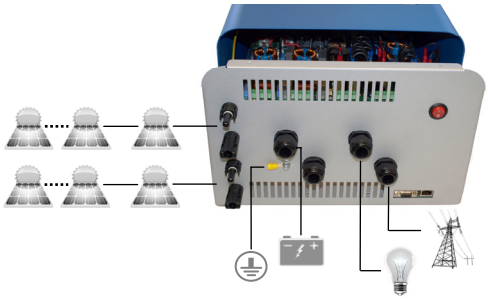


Fig. 7.1. Hybrid System Connections

PROCEDURE OVERVIEW

IPM main switch: OFF

Switch off the main circuit breaker to the building. Make sure all devices to be connected to the IPM are switched to OFF.

Connect the Ground to the IPM chassis.

Connect the load.

Connect the feed in line.

Connect the battery.

Connect the PV.

Switch the IPM main switch to ON.

Switch the building main circuit breaker to ON.

Connections, Step by Step

If the lower cover has not been removed, do so by following the procedure of section 6. Removing the cover exposes the terminal blocks necessary for connecting the IPM to its peripheral devices and networks (Fig. 7.2).

Figures 4.2. and 7.2 show the points that must be connected. From left to right,

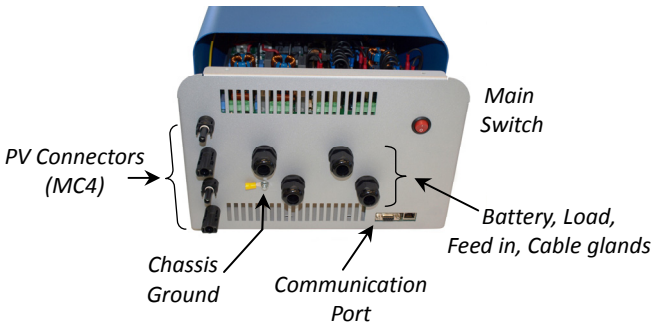


Fig. 4.2 IPM Bottom View

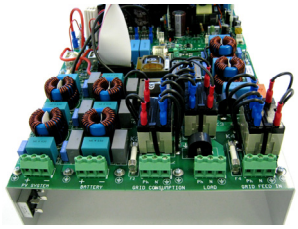


Fig. 7.2 IPM Terminal Blocks

MC4 connectors for PV input,

M6 HEX nut and eyelet terminal for Cassis ground connection,

Cable glands for battery, load, and grid feed in cables. The cables are connected to the corresponding terminal blocks. The terminal block labeled GRID CONSUMPTION is reserved for future connection of a Gen Set.

Connection Sequence

Make sure the IPM switch is set to OFF.

Make sure the building main circuit breaker is set to OFF.

Connect the IPM Ground terminal to the building ground.

Local Load: Use a minimum 2,5 mm^2 cable. Connect the load cable to the IPM, in the sequence, Ground, Phase (Ph), Neutral (N). Install a 25A circuit breaker on this line.

Grid Feed in: Use a minimum 2,5 mm^2 cable. Connect the Grid Feed in cable in the sequence, Ground, Phase, Neutral. Install a 25A circuit breaker on this line.

Battery: Use minimum 2,5 mm^2 cables. Connect the cables to the terminal block of the IPM in the sequence, negative (-), positive (+). Make sure the battery is completely enclosed and there is no chance of human contact to any exposed conductors or parts. Connect the other end of the cable to the battery terminals in the sequence, negative (-), positive (+).

As soon as the above connections are completed, the lower cover may be put back in its place.

Photovoltaic: The two pairs of MC4 connectors are connected in parallel to each other. Each pair may accept up to 450 VDC. Therefore, one or both pairs may be used, depending on system needs. If both are used, make sure the same number of panels is connected to both of them.

Switch the IPM main switch to the ON position.

Switch the building main breaker to the ON position.

Switch the grid breaker to the ON position.

Switch the load breaker to the ON position.

8. OPERATION

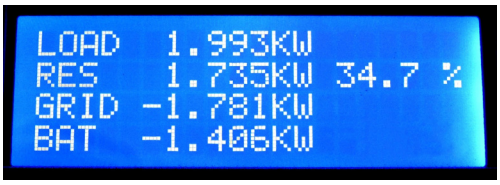
The IPM is the central device of a system that is intended to harvest renewable energy and save on energy consumption. The function of IPM is to manage the energy flow to and from its peripheral devices and the grid. For this reason, it is very important that the user specifies the

Parameters that describe his system and the Parameters that indicate his preferences with regard to energy use.

8.1. Overview

When the IPM main switch is flipped to ON, the device starts operating. Normally, this switch always remains in the ON position. It is only turned off for device or system maintenance.

The IPM is powered by the battery and the photovoltaic. As soon as the voltage of either of these sources is higher than 80 VDC the device powers up. The first display shows Device status:



A series of displays indicate the values of other device Parameters and also values that can be changed according to user preferences.

The displays are arranged in two columns. The *display menu* and the *settings menu*. Four items of each column appear on the screen at any time.

DISPLAY MENU	SETTINGS MENU
Device status	System Setup
Parameter values	Country Specs
Counters I	Operation Mode
Counters II	Feed-In Times
Hardware operation	Grid Consumption
	Bat. Consumption
	Feed-In Pwr Limit
	Inst-Pv Grid
	Inst-Battery
	Factory-CP
	Factory-FP
	Factory-UP

Selections in the SETTINGS MENU are divided in three categories:

1. User displays
2. Installer displays
3. Factory displays

The user Displays may be edited at anytime by the user. They indicate his preferences with regard to system operation and energy management.

The Installer Displays (Prefixed INST) are protected with passwords. They allow a technician to specify system parameters that have to do with hardware installed, like the PV panels and the battery.

The Factory Displays (Prefixed FACTORY) are protected with passwords and are only accessible by the Factory.

The ◀,▶ keys are used for going from the one column to the other. Items in each column are selected with the ▲,▼ keys.

The display menu includes three pages that provide information about the IPM's different functional parameters. It also includes two pages with counters that indicate total and daily energy flow to the grid, to the load, to the battery, and from the Renewable Energy Sources.

The settings menu includes a set of parameters that can be configured according to the user's needs. These parameters allow the user to

1. Input his system characteristics.
2. Configure the total system in a manner that best suits his energy use profile.

Editable displays are accessed by pressing ENTER. Fields to be edited are selected with the ◀,▶ keys. Values change with the ▲,▼ keys. Values are saved by pressing ENTER for 3 seconds. At that time, a prolonged "beep" sounds, confirming the data have been saved. Exiting without saving is accomplished by pressing ENTER once.

The IPM operates in any one of the following user-selectable modes, as shown under "Operation Mode" item.

1. Auxiliary Power Unit
2. Feed-in
3. Island
4. Charger

Changing the operation mode is like installing a different device. For this reason, the IPM returns to its basic configuration of “all OFF” before it assumes the newly selected mode.

1. APU/UPS

In this mode, the IPM functions as an Auxiliary Power Unit. It gives priority to supporting the local loads. Whenever there is loss of power from the grid, the IPM supports its loads through the use of the PV and battery.

Priorities:

1. Support local loads
2. Charge the battery
3. Feed renewable energy into the grid

2. FEED IN

In this mode, the IPM□s main function is to operate as an inverter parallel to the grid. Excess energy is stored in the batteries and fed into the grid.

Priorities:

1. Feed in renewable energy to the grid
2. Charge the battery
3. Support local loads

4. ISLAND

In this mode, the IPM performs local energy management. The system operates as a self-sustained cell that produces, stores and retrieves energy. It uses the energy from the PV to support the local loads and charge the battery. If the energy from the PV is not sufficient, the battery supplies the balance.

Priorities:

1. Support local loads
2. Charge the battery

The local loads are supported only by the local energy.

4. CHARGER

In this mode, the IPM operates as a simple battery charger. The IPM only monitors battery voltage and keeps the battery in a charged state. PV and Grid power is used, depending on availability.

Priorities:

1. Charge the battery

The mode of operation as well as parameter values and preferences are selected by the user through the settings menu. The IPM is equipped with an LCD display and keys (Figure 8.1.) that allow the user to watch the device's status and alter operating parameters.

Fig. 8.1. Display and Keypad

Editable Displays

1	SYSTEM SETUP	Set time and date.
2	COUNTRY SPECS	Select the Country
3	OPERATION MODE	Select APU/UPS ISLAND FEED IN CHARGER
4	FEED IN TIMES	Set the times during which feed in is allowed.
5	GRID CONSUMPTION	Set the times during which the battery may be charged from the grid. The battery must be at or below its minimum voltage.
6	BAT CONSUMPTION	Set the times during which the battery maybe fed into the grid.
7	FEED IN PWR LIMIT	The maximum amount of energy or power

		that may be fed into the grid per day.
8	INST – PV GRID	Set Installation Parameters: PV total power, V_{mpp} Grid Voltage & Frequency
9	INST - BATTERY	Set Battery Parameters: Nominal, Min, Max Voltage. Max Current, Capacity in Ah.
10	FACTORY – CP FACTORY – FP FACTORY - UP	Factory set parameters.

8.2. USER'S INSTRUCTIONS

Use ◀,▶ to select active field. Active field appears blinking.

Press ENTER once to quit without saving.
Press ENTER for 3 seconds to save values.

1. SYSTEM SETUP

Set local time and date.

2. COUNTRY SPECS

Select grid characteristics, according to the country of installation.

3. OPERATION MODE

The IPM may operate in any of four modes, as a different device. Select the mode of operation here.

4. FEED IN TIMES

When the indication "ENABLED" appears, feed in is allowed at all times. Feed in can be restricted to two time intervals per day. Press ▲ to start changing times.

5. GRID CONSUMPTION

When the indication "ENABLED" appears, grid consumption for charging the battery is allowed at all times. It can be restricted to two time intervals per day, as in 4.

6. BAT CONSUMPTION

When the indication “DISABLED” appears, the battery is never fed into the grid. Battery feed in times are set as in 4. If the battery is already in feed in mode, the PV can also be connected for feed in. The opposite sequence is not possible.

7. FEED IN PWR LIMIT

When the indication “LIMITS DISABLED” appears, maximum power and maximum energy are fed into the grid at all times. Use the ◀,▶ keys to set the limit of 1. energy in kWh/day or 2. power as a % of installed power.

8.3. INSTALLER’S INSTRUCTIONS

These displays are protected by a factory-supplied passcode.

8. INST-PV GRID

Set the characteristics of the PV installation and of the local grid.

PV Power: The total power of the PV panels installed.

VMPP: The V_{mpp} voltage of each string (e.g. 9 panels × 31.2 V_{mpp} = 281V).

Grid V F: The local grid voltage and frequency.

9. INST-BATTERY

VbNom: The nominal voltage of the battery.

VbMin: The minimum voltage of the battery. At this point, use of the battery stops.

VbMax: The maximum voltage of the battery. At this point, charging of the battery stops.

Imax: The maximum current allowed when discharging the battery.

CAP: The total capacity of the battery, in Ah.

Vsth: The voltage threshold above which the battery may be fed into the grid.

9. CARE AND MAINTENANCE

The IPM has been designed to operate in an environment protected from the external weather conditions. Once it has been set to operation it does not require any regular maintenance. An occasional dusting once or twice a year is sufficient.

10. WARRANTY

ELFON LTD warrants that this product will be free from defects in materials and workmanship for a period of five (5) years from the date of original purchase. If the product proves defective during this warranty period, ELFON, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify ELFON of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper installation. ELFON shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts to repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

APPENDIX A

TECHNICAL DATA

Technical Data			
		IPM3	**IPM5**
Input Characteristics			
Input Voltage range	V_{DC}	200 to 450 VDC	200 to 450 VDC
MPPT Voltage range	V_{PV}	240 to 400 VDC	240 to 400 VDC
Maximum input current	I_{PVmax}	10A	18A
Nominal output power	P_{DCmax}	3000 kVA	5000 kVA
Overload capacity		110%	110%
Response time		<0.1 sec to extreme step changes	<0.1 sec to extreme step changes
Reverse polarity protection		YES	YES
Overvoltage protection		Varistor	Varistor
Output Characteristics			
Nominal output voltage	V_{AC}	230 VAC	
Grid rejection voltage		180 – 260 VAC	
Output frequency	F_{AC}	50 Hz ± 0.1	
Acceptable grid frequency		46 to 54 Hz	
Stand-by dissipation		<8 W	
Input – Output Isolation		LF transformer	
Efficiency		95%	
Display		4 line LCD	
Communication		RS232, Ethernet	
Cooling method		Forced cooling	
Working Temperature range		0^{o}C to 50^{o}C	
Relative Humidity		95%, non condensing	
Battery			
Voltage		220 – 300 VDC	
Current	I_{max}	25A	
General Characteristics			
Dimensions (cm)		73 x 33 x 25	
Weight		45 kg	
IP Protection		IP20 (Internal Use)	
Certifications		CE EN 62109 – 1, EN 60950 – 1, EN 62040 – 1, EN 60335-2-29	
		EN 61000 – 3 – 2, EN 61000 – 3 – 3, EN 61000 – 6 – 2	

APPENDIX B

LIST OF ALARMS AND ERRORS

ALARM	CONDITION	ERROR
AL41	High Battery Current	NO
AL42	High Inverter Current	NO
AL43	Low Battery Voltage	NO
AL44	High Battery Voltage	NO
AL56	Transformer Overtemperature Warning	NO
AL57	Transformer Overtemperature	ER59
AL66	Power Module Overtemperature Warning	NO
AL67	Power Module Overtemperature	ER69

ERROR	CONDITION	RESETABLE
ER01	Inverter Voltage	YES
ER03	Faulty Pin	YES
ER09	Wrong Connection	NO
ER19	High DC Voltage	YES
ER41	High Battery Current	YES
ER42	High Inverter Current	YES
ER43	Low Battery Voltage	YES
ER45	High Inverter Voltage	YES
ER59	Transformer Overtemperature	YES
ER69	Power Module Overtemperature	YES
ER92	Fuse Fault	NO

Alarms are warnings, indicating a state of pending error. An alarm does not result in equipment stop. An alarm that persists results in an error state.

Errors are system faults that lead to equipment operation halt. When an error appears the IPM will not operate until the error is fixed. A non resettable error requires human intervention and alterations in hardware. A resettable error is the result of prolonged out-of-tolerance operation or instantaneous out-of-tolerance readings. When a resettable

error is encountered, the equipment will stop operating for 30 before it attempts to restart.

As soon as the conditions causing the error disappears, the IPM starts operating again.

APPENDIX C

GLOSSARY

+:	Energy flowing into the IPM
-:	Energy flowing out of the IPM
APU:	Auxiliary Power Unit
BAT:	Battery
GRID:	The public power grid
IPM:	Intelligent Power Manager
kWh:	KiloWattHour (measurement of energy)
PV:	Photovoltaic
RES:	Renewable Energy Sources
UPS:	Uninterrupted Power Supply
V:	Volt (measurement of Potential)
W:	Watt (measurement of electrical current)

APPENDIX D

LIST OF FIGURES

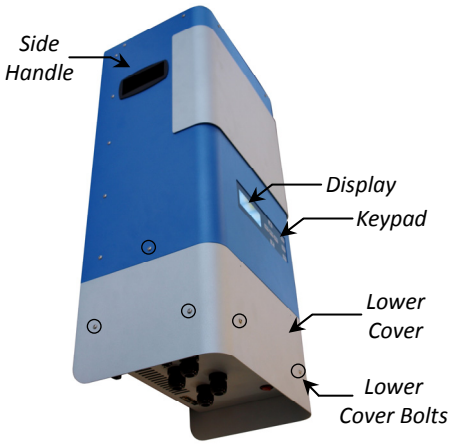


Fig. 4.1 IPM Front View

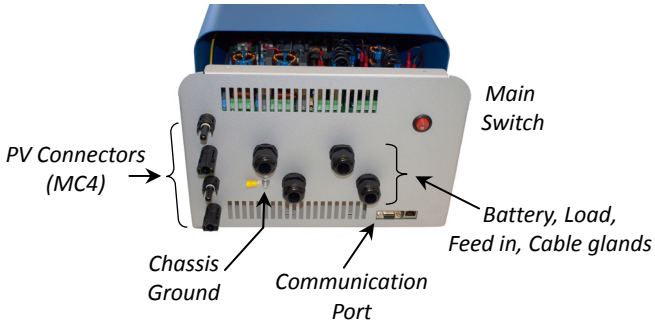


Fig. 4.2 IPM Bottom View

Fig. 4.3 IPM Rear View

Fig. 6.2. Opening the lower cover

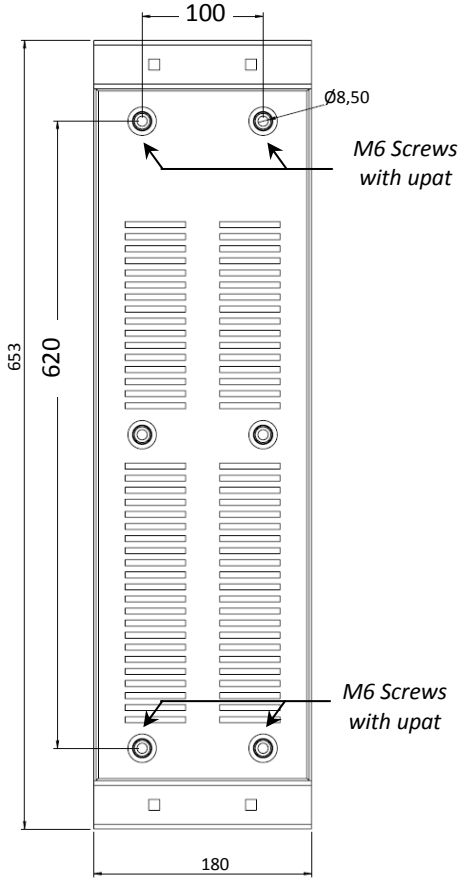


Fig. 6.1 Wall Bracket

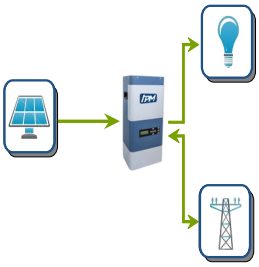


Fig. 6.3. Grid Connected (APU, Feed in)

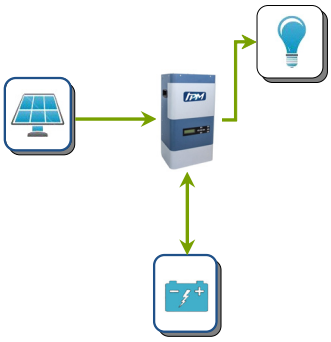


Fig. 6.4. Island

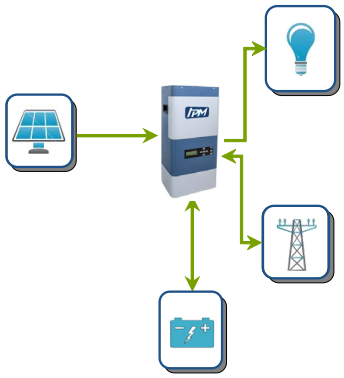


Fig. 6.5. Hybrid (APU)

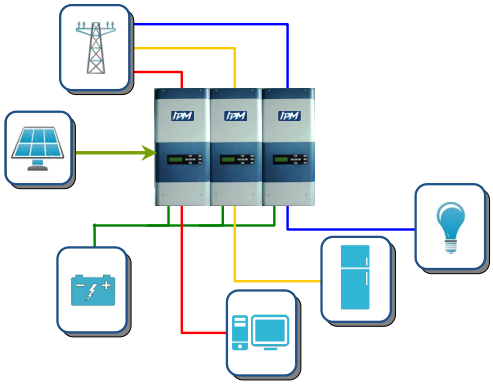


Fig. 6.6. Combined IPMs

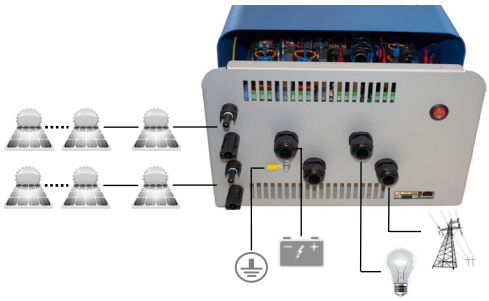


Fig. 7.1. Hybrid System Connections

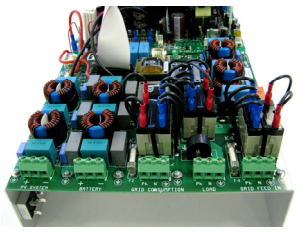


Fig. 7.2 IPM Terminal Blocks